PALAEONTOLOGICAL IMPACT ASSESSMENT FOR THE PROPOSED SPRINGFIELD MINING RIGHT APPLICATION

Issue Date:	18 April 2022
Revision No.:	v3.0
Client:	Glubay Coal (Pty) Ltd, Springfield Colliery
PGS Project No:	451PIA – Springfield Colliery

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Declaration of Independence

I, Elize Butler, declare that –

General declaration:

- I act as the independent palaeontological specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting palaeontological impact assessments, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I will take into account, to the extent possible, the matters listed in section 38 of the NHRA when preparing the application and any report relating to the application;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I will ensure that information containing all relevant facts in respect of the application is distributed or made available to interested and affected parties and the public and that participation by interested and affected parties is facilitated in such a manner that all interested and affected parties will be provided with a reasonable opportunity to participate and to provide comments on documents that are produced to support the application;
- I will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not;
- All the particulars furnished by me in this form are true and correct;
- I will perform all other obligations as expected a palaeontological specialist in terms of the Act and the constitutions of my affiliated professional bodies; and
- I realize that a false declaration is an offense in terms of regulation 71 of the Regulations and is punishable in terms of section 24F of the NEMA.

Disclosure of Vested Interest

I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Regulations;

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SIGNATURE:

ACKNOWLEDGMENT OF RECEIPT

Report Title	**Palaeontological Impact Assessment for the Proposed Springfield Mining Right Application**		
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This Palaeontological Impact Assessment report has been compiled considering the National Environmental Management Act 1998 (NEMA) and Environmental Impact Regulations 2014 as amended, requirements for specialist reports, Appendix 6, as indicated in the table below.

Requirements of Appendix 6 – Government Notice (GN) R326 EIA Regulations of 7 April 2017	**Relevant section in report**	**Comment where not applicable.**
1.(1) (a) (i) Details of the specialist who prepared the report	Page ii and Section 2 of Report – Contact details and company and Appendix A	-
(ii) The expertise of that person to compile a specialist report including a curriculum vita	Section 2 – refer to Appendix A	-
(b) A declaration that the person is independent in a form as may be specified by the competent authority	Page ii of the report	-
(c) An indication of the scope of, and the purpose for which, the report was prepared	Section 4 – Objective	-
(cA) An indication of the quality and age of base data used for the specialist report	Section 5 – Geological and Palaeontological history	-
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 10	-
(d) The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 1 and 9	-
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 7 Approach and Methodology	-
(f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Section 10	-
(g) An identification of any areas to be avoided, including buffers	Section 1 and 11	Buffers or areas of sensitivity identified
(h) A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Section 5 – Geological and Palaeontological history	-
(i) A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 7.1 – Assumptions and Limitation	-
(j) A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 1 and 11	-

Requirements of Appendix 6 – Government Notice (GN) R326 EIA Regulations of 7 April 2017	Relevant section in report	Comment where not applicable.
(k) Any mitigation measures for inclusion in the EMPr	Section 12	-
(l) Any conditions for inclusion in the environmental authorisation	Section 1 and 11	
(m) Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 11	-
(n)(i) A reasoned opinion as to whether the proposed activity, activities or portions thereof should be authorised and	Section 1 and 11	-
(n)(iA) A reasoned opinion regarding the acceptability of the proposed activity or activities; and		-
(n)(ii) If the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Section 1 and 11	-
(o) A description of any consultation process that was undertaken during the course of carrying out the study	N/A	Not applicable. A public consultation process was handled as part of the Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) process.
(p) A summary and copies if any comments that were received during any consultation process	N/A	Not applicable. To date no comments regarding heritage resources that require input from a specialist have been raised.
(q) Any other information requested by the competent authority.	N/A	Not applicable.
(2) Where a government notice by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	Section 3 compliance with SAHRA guidelines	-

EXECUTIVE SUMMARY

Banzai Environmental was appointed by PGS Heritage (Pty) Ltd to conduct the Palaeontological Phase 1 Field Assessment (PIA) assess the Palaeontology for the Springfield Mining Right Application located between Vereeniging and Meyerton in the Gauteng Province. The National Heritage Resources Act (No 25 of 1999, section 38) (NHRA), specifies that a Palaeontological Impact Assessment (PIA) is key to detect the presence of fossil material within the mining rights application area. This PIA of the proposed opencast mine pits is thus necessary to evaluate the effect of the construction on local palaeontological resources.

The geology of the proposed Springfield Project is primarily underlain by the Vryheid Formation (Ecca Group, Undifferentiated Karoo), Precambrian dolomites and associated marine sedimentary rocks that are allocated to the Malmani Subgroup (Chuniespoort Group, Transvaal Supergroup), as well as Quaternary superficial deposits. According to the PalaeoMap on the South African Heritage Resources Information System (SAHRIS) database, the Palaeontological Sensitivity of the Vryheid Formation (Ecca Group, Undifferentiated Karoo) is Very High, while that of the Malmani Subgroup is High and Quaternary deposits is High (Almond and Pether 2008, SAHRIS website). Groenewald and Groenewald 2014 allocated a High Sensitivity to the Malmani Subgroup. They noted that additionally to the stromatolites, potentially fossiliferous Late Caenozoic Cave breccias within the “Transvaal dolomite” outcrop area could be present. These breccias are not individually mapped on geological maps.

The Vryheid Formation comprise of a rich assemblage of Glossopteris flora. The Malmani Subgroup carbonates of the Transvaal Basin comprise of an assortment of stromatolites (microbial laminates), ranging from supratidal mats to intertidal columns and large subtidal domes. Late Cenozoic deposits may contain molluscs, mammalian bones and teeth and horn. Tortoise remains have also been uncovered, as well as trace fossils - which include termite and insect’s burrows and mammalian trackways. Plant remains include leaves, fossil wood, pollen of vascular plants, as well as diatoms.

A one-day site specific field survey of the proposed Springfield Project was conducted on foot and by motor vehicle on 5 September 2020. Several loose stromatolites were identified in a pile in the eastern section of the mining rights application area. There is thus a chance that other stromatolite fossils could be present just below the surface of the mining rights application area. Although this locality does not currently fall in the proposed infrastructure and mining footprint, this fossiliferous site has been identified as Highly Sensitive and No-go areas and it is recommended that a 50 m buffer will be placed around the known stromatolite area. If construction is necessity in this sensitive area, it is recommended that mitigation is conducted by a professional palaeontologist. However, it is highly possible that other fossils could also be present in the mining rights application area. By implementing mitigation measures the significance of the impact will be reduced to **LOW**. Mitigation should take place after initial

vegetation is cleared away but *before* the ground is levelled for construction. Preceding excavation of any fossil material, the specialist would need to apply for a collection permit from SAHRA. Fossil material must be curated in an accredited collection (museum or university collection), while all fieldwork and reports should meet the minimum standards for palaeontological impact studies suggested by SAHRA.

None of the proposed alternatives is preferred as the palaeontological resources will be impacted equally by both the alternatives. The implementation of the recommended mitigation measure will reduce the current HIGH rated impact and will have a post-mitigation rating of LOW.

If fossil remains are discovered during any phase of construction, either on the surface or exposed by fresh excavations the **Chance Find Protocol** must be implemented by the ECO in charge of these developments. These discoveries ought to be protected (if probable, *in situ*) and the ECO must report to SAHRA (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za) so that correct mitigation can be carried out by a paleontologist.

It is consequently recommended that no further palaeontological heritage studies, ground truthing and/or specialist mitigation are required pending the discovery of newly discovered fossils. However, it is recommended that the mitigation measures are included in the EMPr and fully implemented.

Recommendations:

- The EAP and ECO for this project must be informed that Vryheid Formation (Ecca Group, Undifferentiated Karoo), Precambrian dolomites and associated marine sedimentary rocks that are allocated to the Malmani Subgroup (Chuniespoort Group, Transvaal Supergroup), as well as Quaternary superficial deposits has a high to very high Palaeontological Sensitivity.
- Fossils may also be present in the mining rights application area. If fossil remains are discovered during any phase of construction, either on the surface or exposed by new excavations the **Chance Find Protocol** must be implemented by the ECO in charge of these developments. These discoveries ought to be secured (if possible, *in situ*) and the ECO ought to alert SAHRA so that appropriate mitigation (documented and collection) can be undertaken by a palaeontologist.
- These recommendations must form part of the Heritage Management Plan for Springfield Colliery.

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TERMINOLOGY AND ABBREVIATIONS

Cultural significance

This means aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance.

Development

This means any physical intervention, excavation, or action, other than those caused by natural forces, which may in the opinion of the heritage authority in any way result in a change to the nature, appearance or physical nature of a place or influences its stability and future well-being, including:

- construction, alteration, demolition, removal or change in use of a place or a structure at a place;
- carrying out any works on or over or under a place;
- subdivision or consolidation of land comprising a place, including the structures or airspace of a place;
- constructing or putting up for display signs or boards;
- any change to the natural or existing condition or topography of land; and
- any removal or destruction of trees, or removal of vegetation or topsoil

Fossil

Mineralized bones of animals, shellfish, plants, and marine animals. A trace fossil is the track or footprint of a fossil animal that is preserved in stone or consolidated sediment.

Heritage

That which is inherited and forms part of the National Estate (historical places, objects, fossils as defined by the National Heritage Resources Act 25 of 1999).

Heritage resources

This means any place or object of cultural significance and can include (but not limited to) as stated under Section 3 of the NHRA,

- places, buildings, structures, and equipment of cultural significance;
- places to which oral traditions are attached or which are associated with living heritage;
- historical settlements and townscapes;
- landscapes and natural features of cultural significance;
- geological sites of scientific or cultural importance;
- archaeological and palaeontological sites;
- graves and burial grounds; and
- sites of significance relating to the history of slavery in South Africa.

Palaeontology

Any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial use, and any site which contains such fossilised remains or trace.

Table 1: Abbreviations

Abbreviations	**Description**
DIA	Desktop Impact Assessment
DM	District Municipality
ECO	Environmental Control Officer
EAP	Environmental Impact Assessment Practitioner
EIA	Environmental Impact Assessment
EMP/EMPr	Environmental Management Program
GCS	Ground Water Consulting Services
GN	Government Notice
GPS	Global Positioning System
HIA	Heritage Impact Assessment
LM	Local Municipality
MR	Mining Right
NEMA	National Environmental Management Act
NHRA	National Heritage Resources Act
PGS	PGS Heritage
PDA	Palaeontological Desktop Assessment
PIA	Palaeontological Impact Assessment
PSSA	Palaeontological Society of South Africa
SAHRA	South African Heritage Resources Agency
SAHRIS	South African Heritage Resources Information System
WMA	Water Management Area

1 INTRODUCTION

Glubay Coal (Pty) Ltd is an associated company of Canyon Resources (Pty) Ltd (Canyon) which is an exploration and mining company with existing operations in Gauteng and Mpumalanga. Canyon has five operational coal mines, Singani and Hakhano Colliery in the Middelburg region, Phalanndwa and Phalanndwa Extension Colliery in the Delmas region and Khanye Colliery located in the Bronkhorstspruit region. These mines are opencast coal mines, which are mined through the typical truck and shovel method. Synchronised rehabilitation is also conducted at all five sites.

The mine will be situated on the following farms:

- Kookfontein 545 IQ - portions 2, 16, 22, 27, 29, 30, 34, 35, 39, 54, 55, 64, 65, 66, 82, 83, 84 ,85, 93, 95, 97, 99, 100, 102, 105, and 106 (portion numbers changed due to updated cadastre information)
- Damfontein 541 IQ – portions 2, 8, 36 and 37
- Smaldeel 542 IQ - Portions 1 and 4
- Waldrift 599 IQ - Portions 16, 89 and 101
- Vlakfontein 546 IQ - Portion 159

The project is situated in the Sedibeng District Municipality, partially in the Midvaal Local Municipality and partially in the Emfuleni Local Municipality. Refer to Figure 1 and 2 below.

1.1 Project Description

Opencast mining involves the removal of overburden to access the coal. The overburden is stockpiled on site for later use during backfilling of the mined-out void. The acceptable ratio of coal to overburden is broadly governed by prevailing economic factors, linked to the value of the coal set against the cost of extraction. Opencast mining is carried out using diesel-powered equipment and hauling trucks. A stepped approach is provided below:

Step 1: Remove a minimum of 1 metre of topsoil and place directly on levelled spoil. It is recommended that the topsoil stripping operation is carried out for one cut width plus 15 metres ahead of the pit advance. This will ensure that the mining cycle will not be interrupted at any time in order for this essential component to be carried out. The topsoil recovered from the box cut areas is to be placed on a resource dump close to the final voids where it will be required for final closure[1].

Step 2: Remove soft overburden with an excavator and trucks to 2 metres above the hard rock. The 2 metres of soft rock above the hards provides stemming length for the blast holes. By doing this the explosives column can be optimized to fragment the hard rock without incurring excessive fly rock and air blast[1].

Step 3: Drill and blast and remove the remaining overburden to expose the Top Seam. Some overburden will heave beyond the coal edge and therefore will not need to be excavated[1].

Step 4: Mine the Top Seam and the parting to the Lower Seam as well as the Lower Seam (if feasible proceed to Step 6, if not able to mine parting simultaneously refer to Step 5) [1].

Step 5: Remove the inter burden with a dozer push over operation to within 2 to 2.5 metres of the Lower Seam. Use an excavator and truck operation to expose the coal. Mine the Lower Seam[1].

Step 6: The cycle is started again[1].

ROM production will start at approximately 100 000 tons per month and will increase by approximately 100 000 tons per month to an average of 600 000 tons per month during full production. Concurrent rehabilitation will occur during the operational phase by means of the roll over method.

2 QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

The author (Elize Butler) has an MSc in Palaeontology from the University of the Free State, Bloemfontein, South Africa. She has been working in Palaeontology for more than twenty-four years. She has extensive experience in locating, collecting, and curating fossils, including exploration field trips in search of new localities in the Karoo Basin. She has been a member of the Palaeontological Society of South Africa for 14 years. She has been conducting PIAs since 2014.

3 LEGISLATION

3.1 National Heritage Resources Act (25 of 1999)

Cultural Heritage in South Africa, includes all heritage resources, is protected by the National Heritage Resources Act (Act 25 of 1999) (NHRA). Heritage resources as defined in Section 3 of the Act include **"all objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens**".

Palaeontological heritage is unique and non-renewable and is protected by the NHRA. Palaeontological resources may not be unearthed, broken, moved, or destroyed by any development without prior assessment and without a permit from the relevant heritage resources authority as per section 35 of the NHRA.

This Palaeontological Impact Assessment (PIA) forms part of the Heritage Impact Assessment (HIA) and adhere to the conditions of the Act. According to **Section 38 (1)**, an HIA is required to assess any potential impacts to palaeontological heritage within the mining rights application area where:

- the construction of a road, wall, power line, pipeline, canal or other similar form of linear development or barrier exceeding 300 m in length;
- the construction of a bridge or similar structure exceeding 50 m in length;
- any development or other activity which will change the character of a site—

exceeding 5 000 m^2 in extent; or

- involving three or more existing erven or subdivisions thereof; or

- involving three or more erven or divisions thereof which have been consolidated within the past five years; or
- the costs of which will exceed a sum set in terms of regulations by the South African Heritage Resources Authority (SAHRA) or a provincial heritage resources authority; or
- the re-zoning of a site exceeding 10 000 m^2 in extent; or
- any other category of development provided for in regulations by SAHRA or a Provincial heritage resources authority.

Figure 1: Google Earth Image (2020) indicating the location of the proposed Springfield Colliery near Vereeniging in Gauteng.

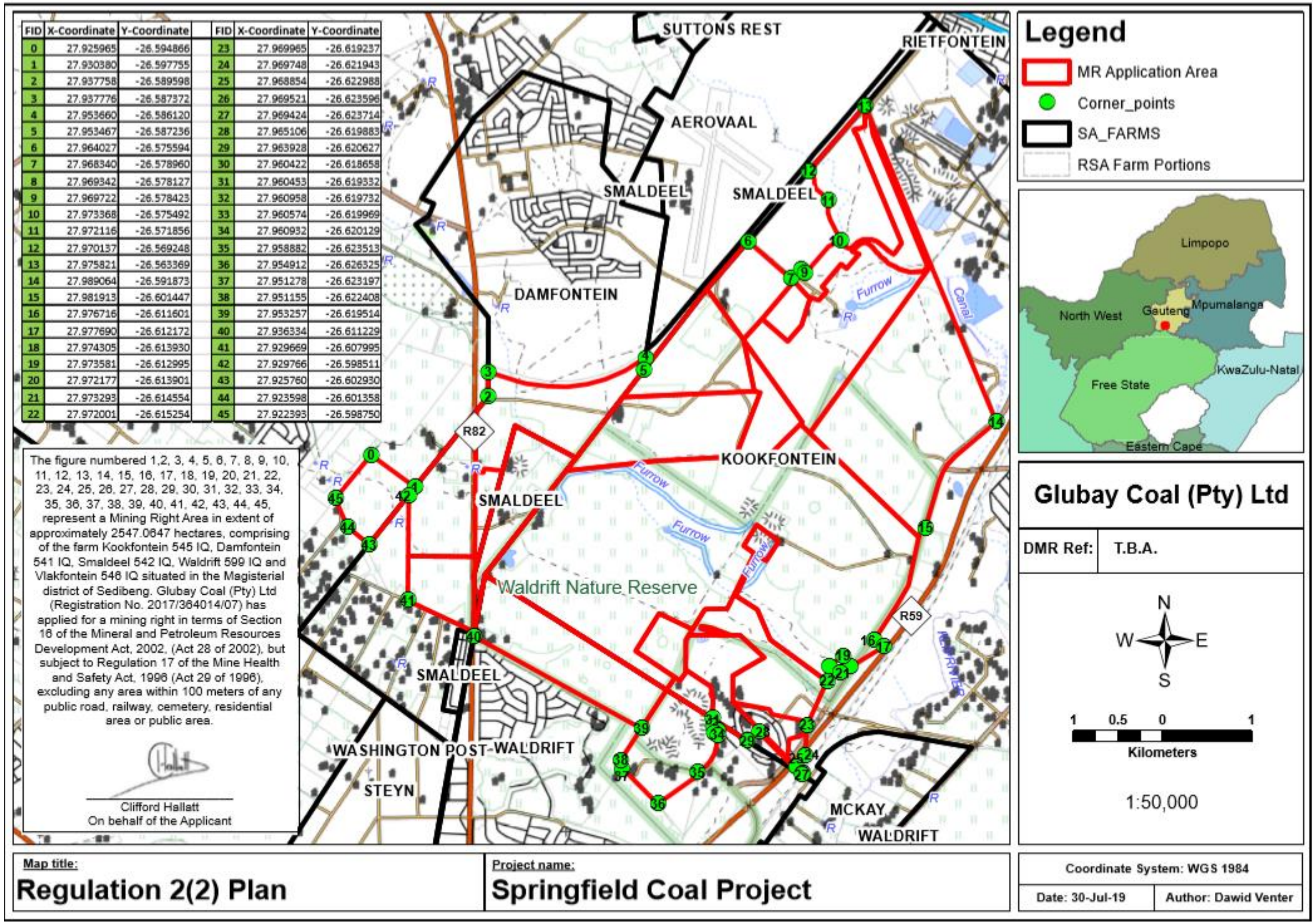


Figure 2: Springfield Coal Project

4 OBJECTIVE

The objective of the report is to determine the impact of the development on potential palaeontological material at the site.

According to the "SAHRA APM Guidelines: Minimum Standards for the Archaeological and Palaeontological Components of Impact Assessment Reports" the aims of the PIA are:

1) to **identify** the palaeontological status of the exposed as well as rock formations just below the surface in the mining rights application area ;
2) to estimate the **palaeontological importance** of the formations;
3) to determine the **impact** on fossil heritage; and
4) to recommend how the developer ought to protect or mitigate damage to fossil heritage.

The terms of reference are as follows:

General Requirements:

- Adherence to the content requirements for specialist reports in accordance with Appendix 6 of the Environmental Impact Assessment (EIA) Regulations 2014, as amended;
- Adherence to all applicable best practice recommendations, appropriate legislation and authority requirements;
- Submit a comprehensive overview of all appropriate legislation, guidelines;
- Description of the proposed project and provide information regarding the developer and consultant who commissioned the study,
- Description and location of the proposed development and provide geological and topographical maps
- Provide Palaeontological and geological history of the affected area.
- Identification sensitive areas to be avoided (providing shapefiles/kml's) in the proposed development;
- Evaluation of the significance of the planned development during the Pre-construction, Construction, Operation, Decommissioning Phases and Cumulative impacts. Potential impacts should be rated in terms of the direct, indirect and cumulative:
    a. **Direct impacts** are impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity.
    b. **Indirect impacts** of an activity are indirect or induced changes that may occur as a result of the activity.
    c. **Cumulative impacts** are impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities.
- Fair assessment of alternatives (infrastructure alternatives have been provided);

- Recommend mitigation measures to minimise the impact of the proposed development; and
- Implications of specialist findings for the proposed development (such as permits, licenses etc, where necessary).

5 GEOLOGICAL AND PALAEONTOLOGICAL HISTORY

The geology of the proposed Springfield Colliery is depicted on the 1:250 000 2626 West Rand Geological Map (Council for Geosciences) (Figure 3). The proposed development is primarily underlain by the Vryheid Formation (Ecca Group, Undifferentiated Karoo), Precambrian dolomites and associated marine sedimentary rocks that are allocated to the Malmani Subgroup (Chuniespoort Group, Transvaal Supergroup), as well as a small area with Quaternary sediments. According to the PalaeoMap on the South African Heritage Resources Information System (SAHRIS) database, the Palaeontological Sensitivity of the Vryheid Formation (Ecca Group, Undifferentiated Karoo) is Very High, while that of the Malmani Subgroup is High and Quaternary deposits is High (Almond and Pether 2008, SAHRIS website). Groenewald and Groenewald 2014 allocated a high Sensitivity to the Malmani Subgroup. They noted that additionally to the stromatolites, potentially fossiliferous Late Caenozoic Cave breccias within the “Transvaal dolomite” outcrop area could be present. These breccias are not individually mapped on geological maps.

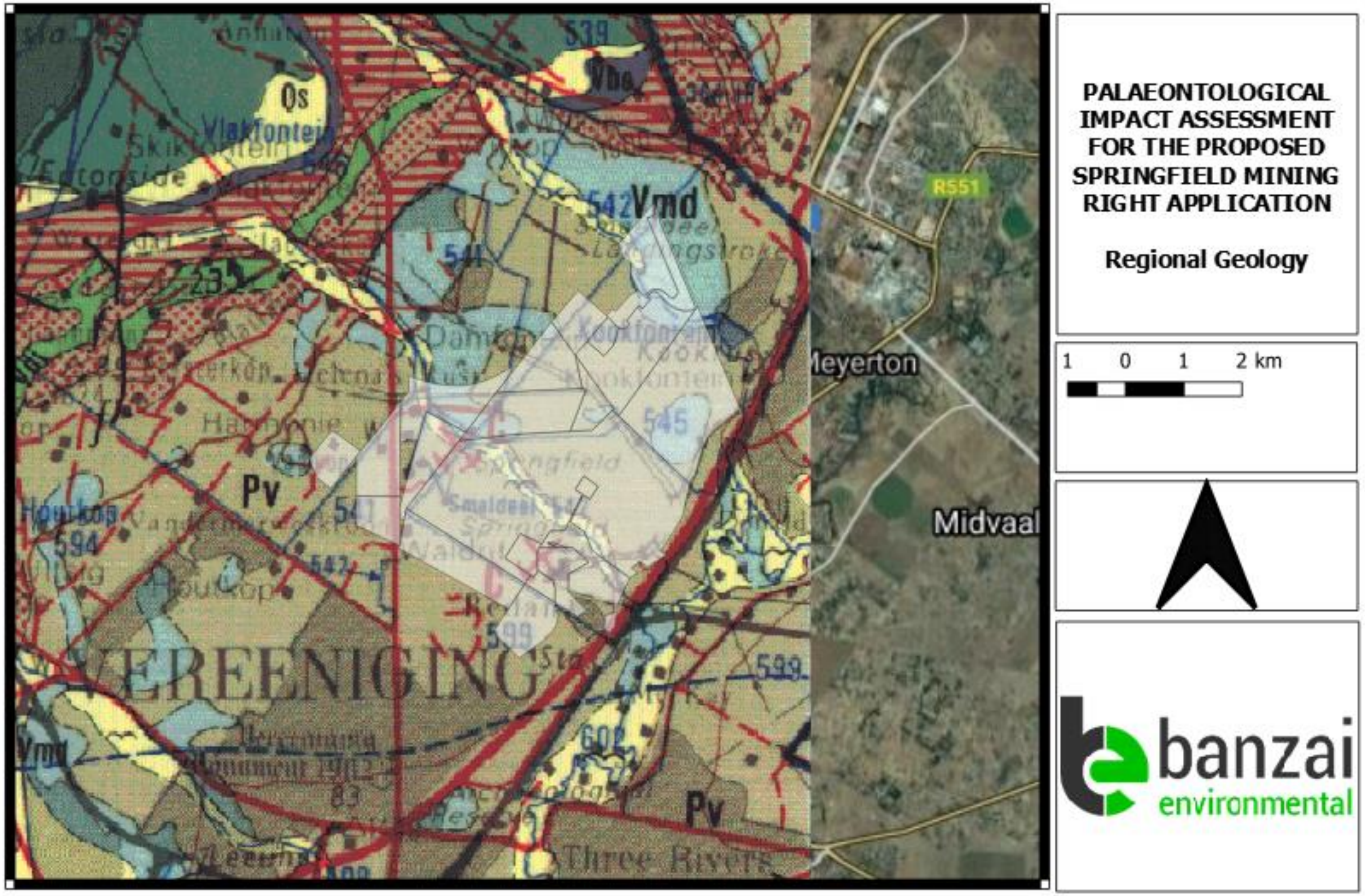
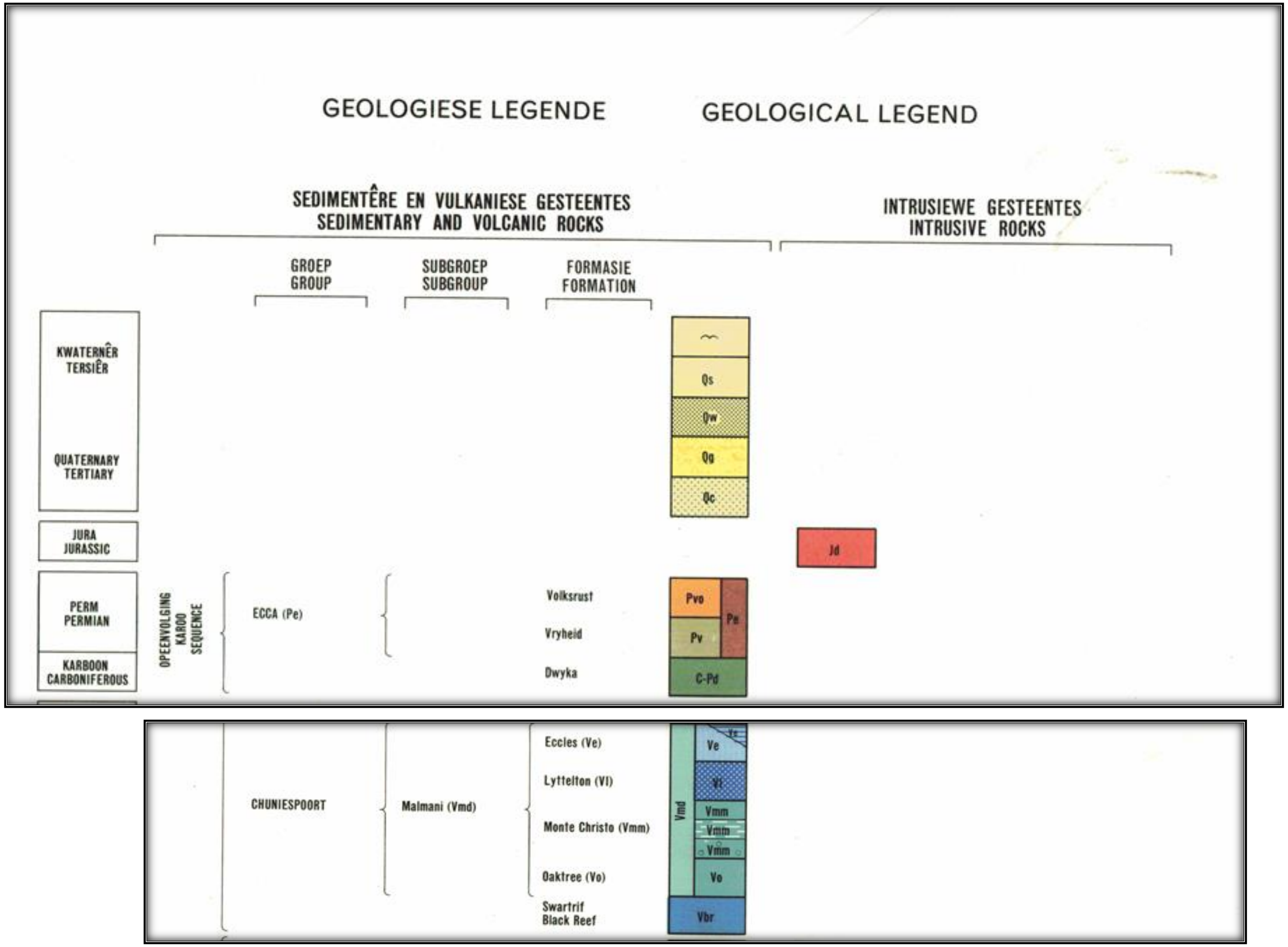


Figure 3: Extract of the 1:250 000 2626 West Rand Geological Map (Council for Geosciences, Pretoria) indicating the geology of the proposed Springfield Mining Project, between Vereeniging and Meyerton in Gauteng. The Project is underlain by the Vryheid Formation (Ecca Group, Undifferentiated Karoo), Malmani Subgroup (Chuniespoort Group, Transvaal Supergroup) and Quaternary deposits. Map drawn by QGIS 2.18.28.


GEOLOGIESE LEGENDE
GEOLOGICAL LEGEND
SEDIMENTÊRE EN VULKANIESE GESTEENTES
SEDIMENTARY AND VOLCANIC ROCKS
INTRUSIEWE GESTEENTES
INTRUSIVE ROCKS
GROEP
GROUP
SUBGROEP
SUBGROUP
FORMASIE
FORMATION
KWATERNÊR
TERSIÊR
QUATERNARY
TERTIARY
JURA
JURASSIC
PERM
PERMIAN
KARBOON
CARBONIFEROUS
OPEENVOLGING KAROO SEQUENCE
ECCA (Pe)
Volksrust
Vryheid
Dwyka
Qs
Qw
Qg
Qc
Jd
Pvo
Pe
Pv
C-Pd
CHUNIESPOORT
Malmani (Vmd)
Eccles (Ve)
Lyttelton (Vl)
Monte Christo (Vmm)
Oaktree (Vo)
Swartrif
Black Reef
Ve
Vl
Vmm
Vmm
Vmm
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Vmd
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Legend Clarification

Qs-Quaternary soil cover

Pe-Ecca Group- Shale, sandstone, coal

Pv- Ecca; Vryheid Formation- Sandstone, shale, coal

Vmd- Malmani Subgroup-dolomite, chert and remnants of chert breccia of Rooihoogte Formation

Mining

C-Coal

Vereeniging-Sasolburg Coalfield

The Springfield Project falls in the Vereeniging-Sasolburg Coalfield which was important historically as it was initially mined to source the first feed for the Sasol One plant to convert coal to liquid fuels and petro-chemicals. Coal appears generally in solitary to partly solitary depositories and thus Steyn & van der Linde in (1986) sub-divided the Vereeniging-Sasolburg Coalfield into three basins, namely the Coalbrook, Cornelia, and Sigma basins.

The northern margin of the Vereeniging-Sasolburg Coalfield is located south of Vereeniging to about 20 km north of Heilbron in the south and east to Deneysville and Sasolburg in the west. The coalfield is about 30 km wide and approximately 50 km long in a north-south direction and is about 208,494 ha in extent (Barker, 1999).

Coal was commercially utilized during the 1880s and 1890s as fuel for the gold and diamond mining industries in the Witwatersrand and Kimberley. Currently only two mines are operational in the Vereeniging-Sasolburg Coalfield, namely the Sigma Colliery which supplies coal to Sasol and an opencast mining operation New Vaal Colliery, which supplies coal to the Lethabo Power Station.

Sigma sub-basin

The Sasol Mining Division's Sigma Colliery is presently the Sigma sub-basin's only coal producer. This Colliery is located directly south of Sasolburg and supplies low-grade coal to the original Sasol plant (later named Sasol One and currently called Sasol Chemical Industries) since 1952. This mine is owned by the Sasol Mining division and comprise of the Sigma/Mohlolo underground and the Wonderwater surface mining operations. Knowledge of the geology and coal resources of the Sigma sub-basin is based on these mines.

The Sigma sub-basin is located along a north-south line at the western edge of the Vereeniging-Sasolburg Coalfield. The western margin of the sub-basin is formed by a pre-Karoo outcrop of the Vredefort Dome and in the east by a ridge of the Ongeluk Formation (Transvaal Supergroup) lava, which divides it to the east from the Cornelia sub-basin.

The Sigma sub-basin is underlain by rocks of the Transvaal and Ventersdorp supergroups (Nel and Jansen, 1957; Fig. 24). Lavas of the Ventersdorp Supergroup are mainly uncovered in an area in the central part of the sub-basin. Outcrops of Transvaal Supergroup dolomites extend from close to the Klip River southwards to Vereeniging and beyond (Van der Linde, 1979). Volcanic rocks of the Hekpoort Andesite Formation have been uncovered in boreholes along the north-eastern part of the Sigma sub-basin. Sasol's Wonderwater surface mine is underlain by lavas of the Ventersdorp Supergroup and the topography is smooth which gives rise to flat lying coal seams. Generally, the palaeoslope is from north to south with a dip of less than a degree. Dwyka Group diamictites is present at the base of the sequence and are thickest in areas overlying dolomites

Dolerite sills of up to 35 m, cover large areas in the Sigma sub-basin. These sills have in places a profound impact on the volatile content of the coal and affects the rock mechanics of the mining operations (De Beer et al., 1991). Two large dolerite sills occur in the southern sector of Sigma sub-basin. Most dolerite dykes are in the southern sector of the Sigma Colliery underground mining operations. Associated post-Karoo faults, with displacements of up to 4 m have been encountered (Steyn and Van der Linde, 1986).

Cornelia sub-basin

The New Vaal Colliery (NVC) is in the Cornelia sub-basin. This mine was an underground colliery and was revived by opencast mining methods. Lethabo was fully operational by December 1990. This power station burns the lowest CV (15-16 MJ/kg) and highest Ash (42%) coal in South Africa.

The proposed **Springfield Colliery falls in the Cornelia** sub-basin that forms the north-eastern margin of the Vereeniging-Sasolburg Coalfield. This sub-basin expands in a north-south direction from the Vereeniging in the north to the northern border of the Coalbrook sub-basin in the south. Lavas of the Ongeluk Formation form the western boundary of the Sigma sub-basin and the eastern boundary by the subcrop against a basement comprised of the Chuniespoort Group.

The northern part of the Cornelia Basin is underlain by dolomites of Chuniespoort Group and lavas of the Hekpoort Formation (Transvaal Supergroup). The depth of the basal Dwyka Group commonly fluctuates between 3-4 m, but can reach up to 15 m. The lower portion of the Dwyka Group is formed by diamictite. Well-rounded pebble sized to angular clasts of chert, dolomite, and metaquartzite set in a brown argillaceous matrix is also present. The diamictite facies is overlain by inconstant layers of sandstone and reworked diamictite. The thickness of these layers fluctuates between 4-5 m and forms the floor to the Bottom Coal Seam. A thin coal seam is present in the northern part of the sub-basin.

A graben-type structure in the Cornelia sub-basin was produced by two major faults with a regular east-west strike. The shift of the coal units differs from only 5 m in the east to as much as 70 m in the west. Minor faulting occurs in the Bottom Seam while a few of these faults can be found up to the Middle Seam (Steyn and Van der Linde, 1986).

In the upper part of the succession a dolerite sill up to 60 m thick occurs but through erosion this thins to the north. The occurrence of floor dips, faults, sinkholes makes for challenging mining conditions at New Vaal Colliery.

Coalbrook sub-basin

This sub-basin is a southernly extension of the Sigma and Cornelia sub-basins and extends from the southern edges of the Sigma and Cornelia sub-basins southwards towards Heilbron and eastwards to the Vaal Dam. This basin is currently without an active colliery.

Quaternary superficial deposits

Quaternary superficial deposits are the youngest geological deposits formed during the most recent period of geological time (approximately 2.6 million years ago to present). The rocks and sediments can be found at or near the surface of the Earth. Pre-Quaternary deposits are referred to as bedrock. Most of the superficial deposits are unconsolidated sediments and consist of gravel, sand, silt and clay, and they form relatively thin, often discontinuous patches of sediments or larger spreads onshore. These sediments may include stream, channel and floodplain deposits, beach sand, talus gravels and glacial drift sediments (Partridge *et al*, 2006).

Late Cenozoic deposits may contain molluscs, mammalian bones and teeth and horn. Tortoise remains have also been uncovered, as well as trace fossils - which include termite and insect's burrows and mammalian trackways. Plant remains include leaves, fossil wood, pollen of vascular plants, as well as diatoms.

Vryheid Formation

The coalfields of South African occur in the Main Karoo Basin or its associated sub-basins. The Main Karoo Basin forms part of a series of Gondwanan basins that was established along the southern boundary of Gondwana (Cole, 1992; De Wit and Ransome 1992; Veevers *et al*. 1994; Catuneanu *et al*. 1998). These basins include Beacon Basin in Antarctica, Bowen Basin in Australia as well as the Paraná Basin in South America. The Basins were formed between the Late Carboniferous and Middle Jurassic and their joint stratigraphies portray the best non-marine sedimentation record globally.

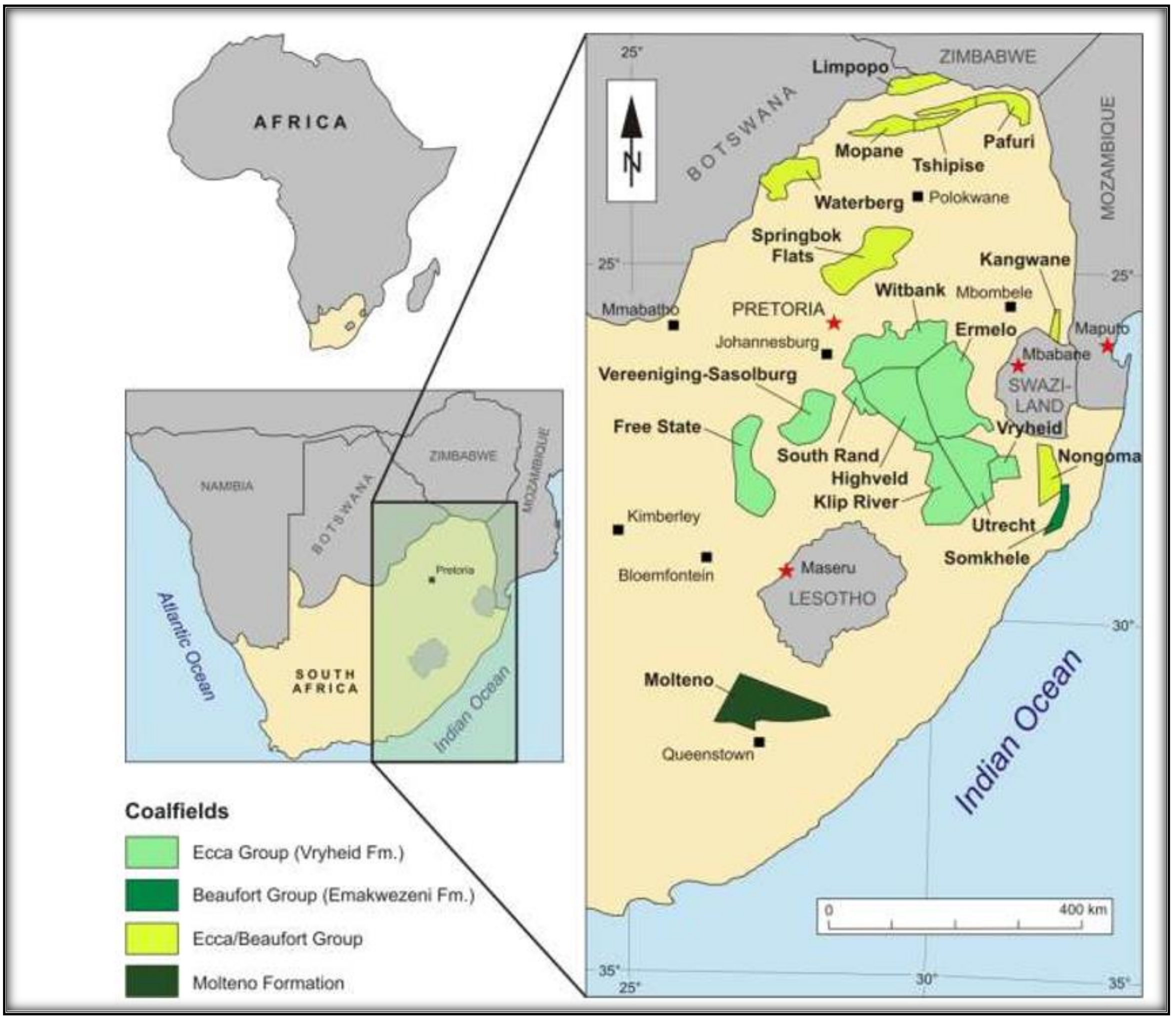

Figure 4: Coalfields of Southern Africa, taken from Hancox and Götz (2014).

Most of the coal mined in South Africa originates in the Permian Vryheid Formation (Figure 4).
The **Vryheid Formation** comprises mudrock, rhythmite, siltstone and fine- to coarse-grained sandstone (pebbly in places). The Formation contains up to five (mineable) coal seams. The different lithofacies are mainly arranged in upward-coarsening deltaic cycles (up to 80m thick in the southeast). Fining-upward fluvial cycles, of which up to six are present in the east, are typically sheet-like in geometry, although some form valley-fill deposits. They comprise coarse-grained to pebbly, immature sandstones - with an abrupt upward transition into fine-grained sediments and coal seams.

The Vryheid Formation comprise of a rich assemblage of Glossopteris flora. After continental deglaciation took place Gymnospermous glossopterids (Figure 5) dominated the peat and non-peat accumulating Permian wetlands (Falcon, 1986, Greb *et al*., 2006).

Table 2: Ecca Group and Formations. (Modified from Johnson et al, 2006).

Period	Supergroup	Group	Formation West of 24º E	Formation East of 24º E	Formation Free State / KwaZulu Natal
Permian	Karoo Supergroup	Ecca Group	Waterford Formation	Waterford Formation	Volksrust Formation
			Tierberg / Fort Brown Formation	Fort Brown Formation	
			Laingsburg / Rippon Formation	Rippon Formation	Vryheid Formation
			Collingham Formation	Collingham Formation	Pietermaritzburg Formation
			Whitehill Formation	Whitehill Formation	
			Prince Albert Formation	Prince Albert Formation	Mbizane Formation

Recent paleobotanical studies in the Vryburg Formation include that of Bordy and Prevec (2008) and Prevec *et al.* (2008, 2009, 2010) and Prevec, (2011). Bamford (2011) described numerous plant fossils from this formation (e.g. *Azaniodendron fertile*, *Cyclodendron leslii, Sphenophyllum hammanskraalensis, Annularia sp., Raniganjia sp., Asterotheca spp., Liknopetalon enigmata, Hirsutum* sp., *Scutum* sp., *Ottokaria* sp., *Estcourtia* sp., *Arberia* sp., *Lidgetonnia* sp., *Noeggerathiopsis* sp., *Podocarpidites* sp as well as more than 20 Glossopteris species.

In the past, palynological studies have focused on the coal-bearing successions of the Vryheid Formation and include articles by Aitken (1994, 1998), and Millsteed (1994, 1999), while recent studies focussed on the Witbank Coalfield were conducted by Götz and Ruckwied (2014).

Bamford (2011) is of the opinion that only a small amount of data has been published on these potentially fossiliferous deposits and that most likely good material is present around coal mines and in other areas the exposures are poor and of little interest. When plant fossils do occur, they are usually abundant. According to Bamford, it is not feasible to preserve all the sites but in the interests of science these sites ought to be well documented, researched and the collected fossils must be housed in an accredited institution.

To date no fossil vertebrates have been collected from the Vryheid formation. The occurrence of fossil insects is rare, while palynomorphs are diverse. Fish scales and non-marine bivalves have been reported. Trace fossils are found abundantly but the diversity is low. The mesosaurid reptile, *Mesosaurus* (Figure 6) has been found in the southern parts of the basin but may also be present in other areas of the Vryheid formation. Regardless of the rare and irregular occurrence of fossils in this biozone, a single fossil may be of scientific value as many fossil taxa are known from a single fossil.

Figure 5: Glossopteris leaf.

Figure 6: Mesosaurus sp. https://www.google.com/

The Malmani Subgroup

The Malmani Subgroup carbonates of the Transvaal Basin (Figure 7 & 8) comprise of an assortment of stromatolites (microbial laminates), ranging from supratidal mats to intertidal columns and large subtidal domes (Eriksson *et al.* 2006). Stromatolites are layered mounds, columns and sheet-like sedimentary rocks (Figure 8). These structures were originally formed by the growth of layer upon layer of cyanobacteria, a single-celled photosynthesizing microbe. Cyanobacteria are prokaryotic cells (simplest form of modern carbon-bases life). Stromatolites are first found in Precambrian rocks and are known as the earliest known fossils. The oxygen atmosphere that we depend on today was generated by numerous cyanobacteria photosynthesizing during the Archaean and Proterozoic Era.

Stromatolites and oolites from the Transvaal Supergroup have been described by various authors (Eriksson and Altermann, 1998). Detailed descriptions of South African Archaean stromatolites are available in the literature (Altermann, 2001; Buick, 2001; and Schopf, 2006). The Malmani stromatolites literature includes articles by Truswell and Eriksson (1972, 1973, 1975), Eriksson and MacGregor (1981), Eriksson and Altermann (1998), Sumner (2000), Schopf (2006).

The Malmani Subgroup succession is about 2 km-thick and consists of a series of formations of oolitic and stromatolitic carbonates (limestones and dolomites), black carbonaceous shales and minor secondary cherts. The Malmani Dolomites also consist of historic lime mines, and palaeocave fossil deposits. Dolomite (limestone rock) forms in warm, shallow seas from slow gathering remainders of marine microorganisms and fine-grained sediment. Dolomites of the Malmani Subgroup have a higher magnesium content than other limestones. These materials contain high levels of calcium carbonate and are often referred to as *carbonates*.

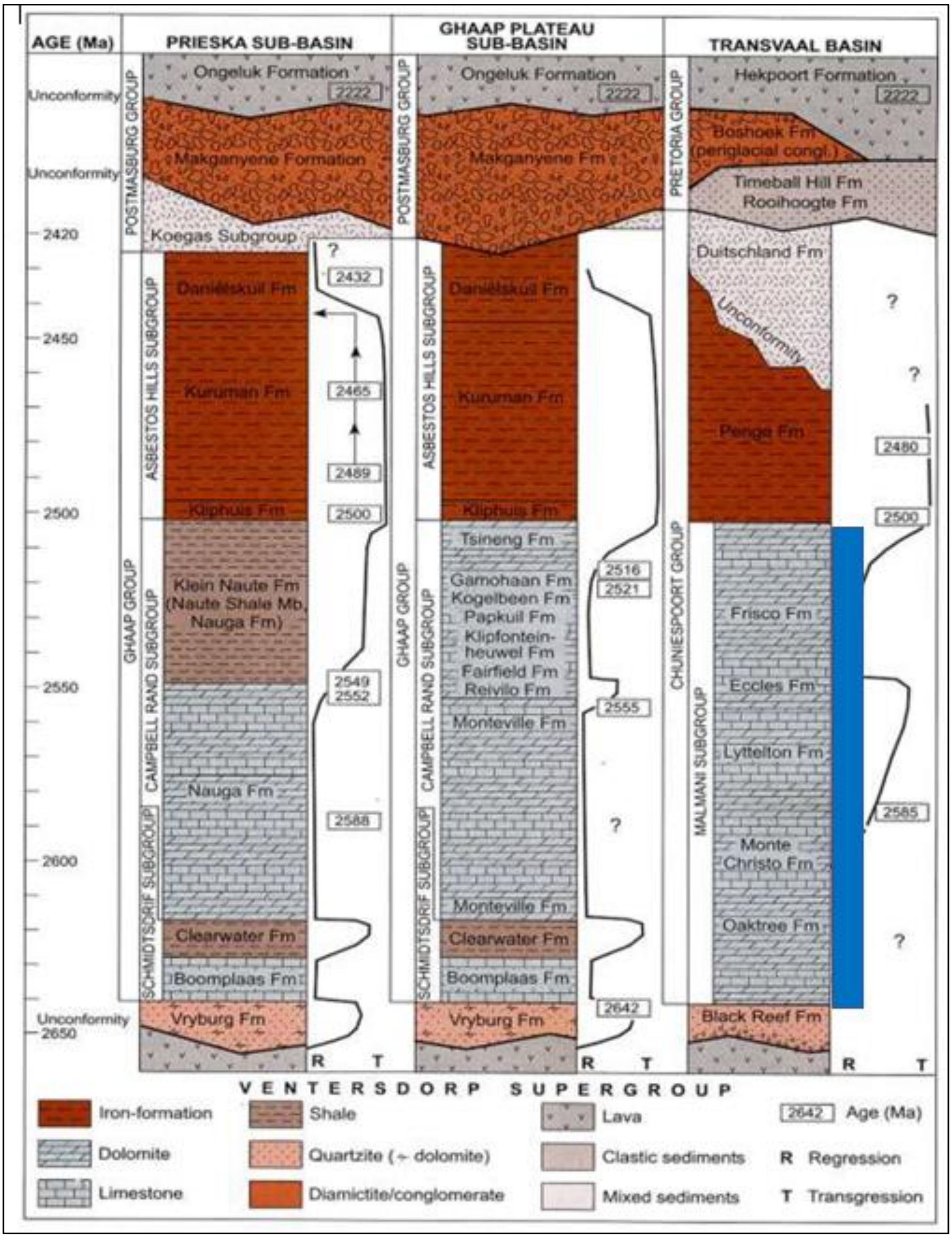

Figure 7: Stratigraphy of the Transvaal Supergroup. The geology affected by the proposed development is indicated in blue (Eriksson, et al. 2006).

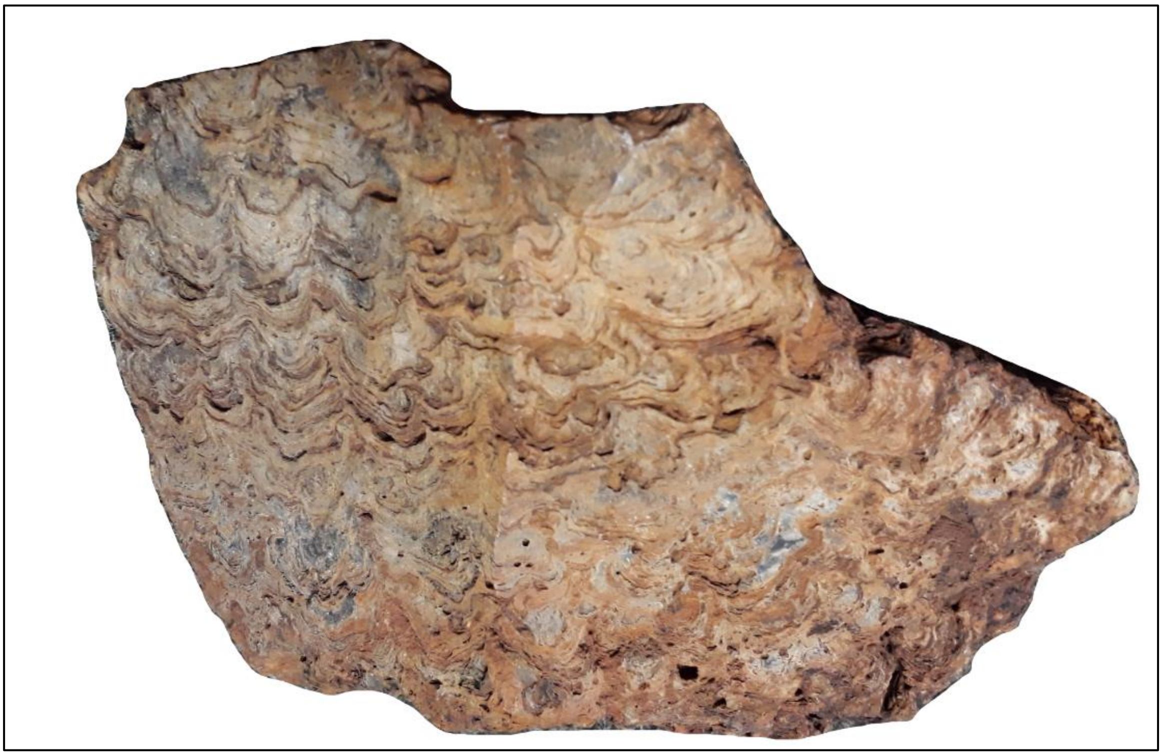

Figure 8: Example of a well-preserved stromatolite from the Archaean Era.

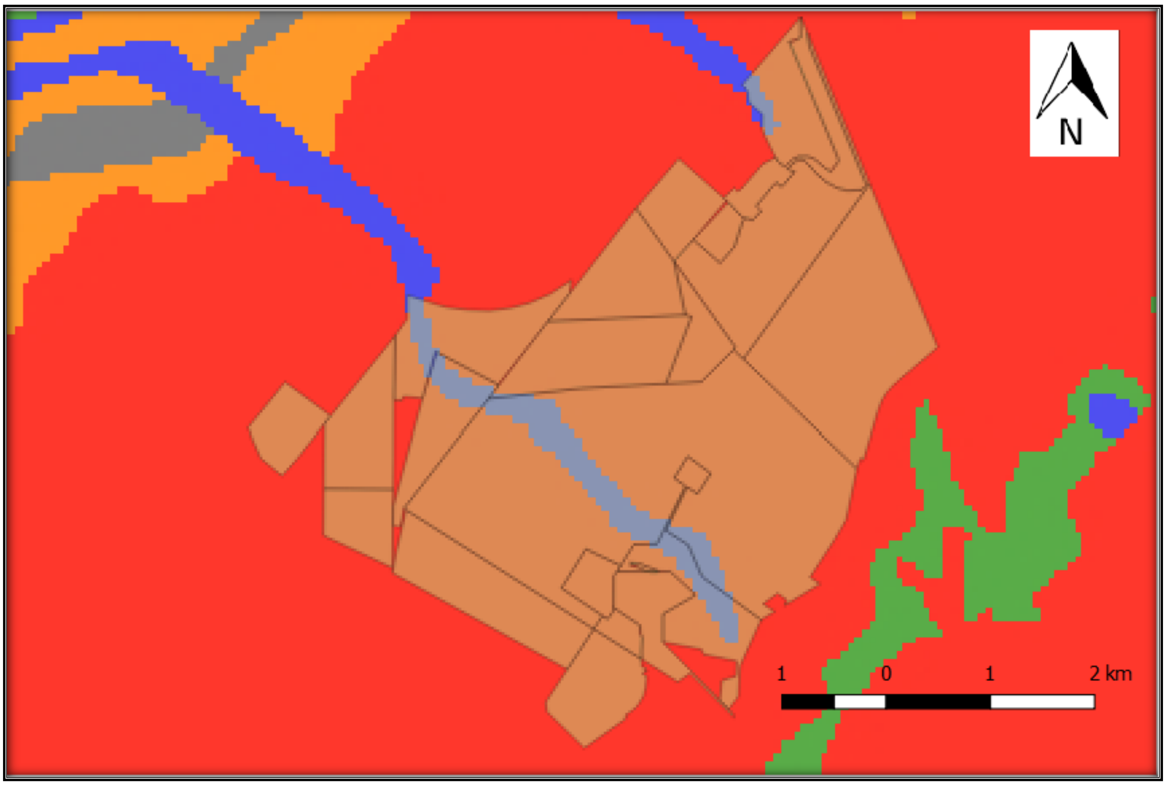

Figure 9: Extract of the 1 in 250 000 SAHRIS PalaeoMap map (Council of Geosciences) indicating the locality of the proposed Springfield Colliery.

Table 3: SAHRIS recommendations

Colour	Sensitivity	Required Action
RED	**VERY HIGH**	**field assessment and protocol for finds is required**
ORANGE/YELLOW	HIGH	desktop study is required and based on the outcome of the desktop study, a field assessment is likely
GREEN	MODERATE	desktop study is required
BLUE	LOW	no palaeontological studies are required however a protocol for finds is required
GREY	INSIGNIFICANT/ZERO	no palaeontological studies are required
WHITE/CLEAR	UNKNOWN	these areas will require a minimum of a desktop study. As more information comes to light, SAHRA will continue to populate the map.

According to the SAHRIS palaeosensitivity map (Figure 9), there is very high possibility of finding fossils in this area (Table 3) and a field assessment and protocol for finds is required.

6 GEOGRAPHICAL LOCATION OF THE SITE

The mine will be located on:

- Kookfontein 545 IQ - portions 2, 16, 22, 27, 29, 30, 34, 35, 39, 54, 55, 64, 65, 66, 82, 83, 84 ,85, 93, 95, 97, 99, 100, 102, 105, and 106 (portion numbers changed due to updated cadastre information)
- Damfontein 541 IQ – portions 2, 8, 36 and 37
- Smaldeel 542 IQ - Portions 1 and 4
- Waldrift 599 IQ - Portions 16, 89 and 101
- Vlakfontein 546 IQ - Portion 159

The Springfield Project is approximately 65 km south of Johannesburg in Gauteng and is positioned between Vereeniging and Meyerton within the old workings of the now defunct Springfield Colliery. The project site can be accessed by tarred road (R59 and M61) while a railway line passes the project area in the east[1]

7 METHODS

The aim of this study is to evaluate the risk to palaeontological heritage in the proposed development. This includes all trace fossils and fossils. All available information is consulted to compile this study and includes PIA reports in the same area; aerial photos and Google Earth images, topographical as well as geological maps.

7.1 Assumptions and Limitations

The accuracy of a Palaeontological Desktop Assessment (PDA) is reduced by several factors which may include the following: the databases of institutions are not always up to date and relevant locality and geological information were not documented accurately in the past. Various remote areas of South Africa have not been assessed by palaeontologists and data is based on aerial photographs alone. Geological maps concentre on the geology of an area and the sheet explanations were never intended to focus on palaeontological heritage.

Similar Assemblage Zones, but in different areas, are used to provide information on the presence of fossil heritage in an unmapped area. Desktop studies of similar geological formations and Assemblage Zones generally **assume** that exposed fossil heritage is present within the development area. **The accuracy of the Palaeontological Impact Assessment is thus improved considerably by conducting a field-assessment completed for this project.**

8 ADDITIONAL INFORMATION CONSULTED

In compiling this report the following sources were consulted:

- Geological map 1:100 000, Geology of the Republic of South Africa (Visser 1984)
- A Google Earth map with polygons of the proposed development was obtained from PGS Heritage (Pty) Ltd.
- 1:250 000 22626 West Rand Pretoria Geological Map
- A few previous PIA's near the development site which were consulted include Bamford 2016 Bamford, 2017a, Bamford 2017b, Bamford 2018, Fourie 2015, Hancox 2011, 2014, Millsteed, 2013. See references.

9 SITE VIST

A one-day site specific field survey of the Springfield Colliery was conducted on foot and by motor vehicle on 5 September 2020. Several loose stromatolites were identified in a pile in the eastern side of the mining right application area, outside the proposed infrastructure and mining footprint areas. No other visible evidence of fossiliferous outcrops was identified during the site investigation but it is highly possible that other stromatolite fossils could be present just below the surface of the development footprint.

The following photographs were taken within the mining right application area during the site visit to the proposed Springfield Project, near Vereeniging, Gauteng Province.

Figure 10: Harvested corn crops

GPS coordinates: 26° 36’ 26”S 27° 56’ 21”E

Figure 11: Harvested corn crops

GPS coordinates: 26° 36’ 21”S 27° 56’ 50”E

Figure 12: Low relief without fossiliferous outcrops

GPS coordinates: 26° 34’ 41”S 27° 59’ 16”E

Figure 13: Small water body

GPS coordinates: 26° 36’ 30”S 27° 57’ 48”E

Figure 14: Agricultural field

GPS coordinates: 26° 37’ 22S 27° 58 24E

Figure 15: Vegetation without fossiliferous outcrops

GPS coordinates: 26° 37’ 01”S 27° 56’ 20”E

Figure 16: Stromatolite

GPS coordinates:26° 35’ 40”S 27° 58’ 54”E

Figure 17: Stromatolite

GPS coordinates:26° 35’ 40”S 27° 58’ 54”E

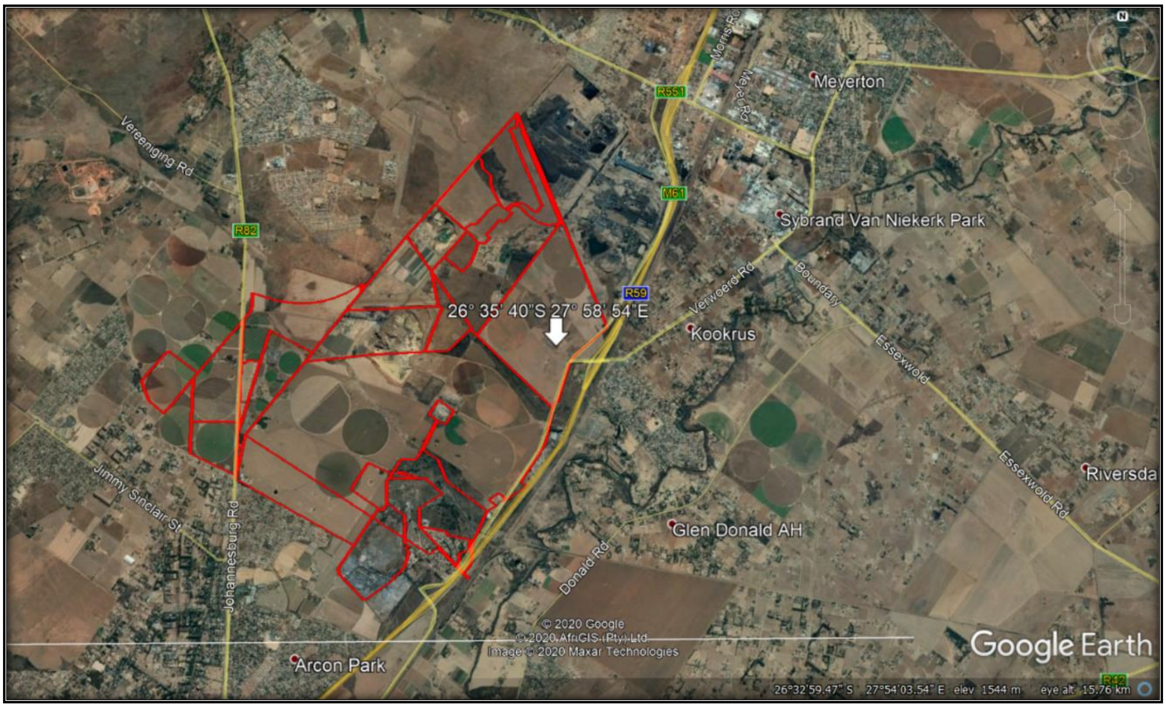

Figure 18: Location of stromatolite pile

GPS coordinates:26° 35' 40"S 27° 58' 54"E

10 IMPACT ASSESSMENT METHODOLOGY

The methodology used determines the significance of the impacts by evaluating the consequence (extent, duration, and severity) and likelihood (probability and frequency of activity) of each impact. The definitions of the terms used within the methodology are provided below, followed by the stepped approach.

Definitions

Aspect	a particular part or feature of something.
Impact	is defined as any change to the environment, whether positive or negative, resulting from a facility/project/development's products, development, and activities.
Cause/Activity	the precipitating factor resulting in a perceived impact.
Mitigation Measures	identified actions and requirements designed to be instituted to reduce the undesirable effects of a perceived impact.
Significance Level	the degree of importance of the impact on the social and/or biophysical environment; a proxy for the degree to which the impact is reversible and may cause irreplaceable loss of a resource. The approach used to determine significance makes use of value judgements to determine the degree of change on the social and/or biophysical environment, after which the consequence and likelihood of the impact are ranked to provide a significance level.
Extent	the spatial scope of the perceived impact. (How large an area will be impacted). Duration – the temporal scope of the perceived impact, or the period of time during which the social and/or biophysical environment is changed by the impact. (How long the impact will last). Severity – the degree to which the natural, cultural, and/or social functions and processes of an environment may be affected or altered by a perceived impact. (How extreme/harsh the impact will be. The degree of disturbance).

Duration	the temporal scope of the perceived impact, or the period of time during which the social and/or biophysical environment is changed by the impact. (How long the impact will last).
Severity	the degree to which the natural, cultural, and/or social functions and processes of an environment may be affected or altered by a perceived impact. (How extreme/harsh the impact will be. The degree of disturbance).
Reversibility	the degree to which the impact can be reversed.
Probability	the possibility or likelihood of the impact occurring or manifesting.

1 APPROACH

The stepped approach used is provided below:

Step 1: The different aspects of the proposed project are identified along with the associated environmental and social impacts which may occur during each phase of the project.

Step 2: Assess the consequence of the impact by providing a numerical score for each of the following factors using the ranking scales in Table 2: Variables with each category score:

- Extent;
- Duration;
- Severity;
- Reversibility.

The consequence is determined using the sum of the extent, duration, severity, and reversibility variables. The maximum value of points (SP) is 25.

Step 3: Assess the likelihood of the impact by providing a numerical score for each of the following factors using the ranking scales in Table 2-: Variables with each category score:
Probability of the impact.

The likelihood is determined using the probability frequency variables. The maximum value of points (SP) is 5.

Step 4: Once these factors are ranked for each impact, the significance points are calculated by using the formula below.

SP (Significant Points) = Consequence (Extent + Duration + Severity + Reversibility) x Likelihood (Probability)

Step 5: Mitigation measures for each impact are determined as part of the impact assessment, and the above approached is repeated to determine the significance of each impact post-mitigation.

2 SIGNIFICANCE LEVEL

The maximum value is 125 significant points. The significance level of the impact could therefore be rated as either Very High (VH), High (H), Medium (M), Low (L), or Very Low (VL) on the following basis:

Table 1: Significance levels

Very Low	Negligible impact which does not require further mitigation.	**SP ≤25**
Low	Acceptable impact for which mitigation is desirable but not essential. The impact by itself is insufficient even in combination with other low impacts to prevent the implementation of the project. These impacts will result in either positive or negative medium to short term effects on the social and/or natural environment	**SP 26-50**
Medium	An important impact which requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in either a positive or negative medium to long-term effect on the social and/or natural environment.	**SP 51-75**
High	A serious impact, if not mitigated, may prevent the implementation of the project. These impacts would be considered by society as constituting a major and usually a long-term change to the (natural &/or social) environment and result in severe negative or beneficial effects.	**SP 76-100**
Very High	A very serious impact which, if negative, may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are unmitigable and usually result in very severe negative or very beneficial effects.	**SP 101-125**

Table 4: Impact scores

	Pre-Mitigation							Post Mitigation						
Impact	**Phase**	**Extent**	**Duration**	**Severity**	**Reversibility**	**Probability**	**Pre-mitigation SP**	**Extent**	**Duration**	**Magnitude**	**Reversibility**	**Probability**	**Post-mitigation SP**	**Final score**
Impact on palaeontological resources	Construction and Operational	1	5	8	5	4	76	1	5	4	5	2	30	30,00

2.1 Summary of Impact Tables

As noted above, the geology of the proposed Springfield Colliery is primarily underlain by the Vryheid Formation (Ecca Group, Undifferentiated Karoo), and by Precambrian dolomites and associated marine sedimentary rocks that are allocated to the Malmani Subgroup (Chuniespoort Group, Transvaal Supergroup). According to the PalaeoMap on the SAHRIS database, the Palaeontological Sensitivity of the Vryheid Formation (Ecca Group, Undifferentiated Karoo) is **Very High** while that of the Malmani Subgroup is **High** and Quaternary deposits is **High** (Almond and Pether 2008, SAHRIS website).

The Vryheid Formation comprise of a rich assemblage of Glossopteris flora. Gymnospermous glossopterids dominated the peat and non-peat accumulating Permian wetlands. The Malmani Subgroup carbonates of the Transvaal Basin comprise of an assortment of stromatolites (microbial laminates), ranging from supratidal mats to intertidal columns and large subtidal domes. Late Cenozoic deposits may contain molluscs, mammalian bones and teeth and horn. Tortoise remains have also been uncovered, as well as trace fossils - which include termite and insect's burrows and mammalian trackways. Plant remains include leaves, fossil wood, pollen of vascular plants, as well as diatoms.

Impacts on fossil heritage will only happen in the construction and mining phases. The extent of the area of potential impact is restricted to the footprint areas of the project. The expected duration of the impact is assessed as potentially permanent. The severity of the impact will be VERY HIGH and extremely harmful to the fossil heritage in the absence of suitable mitigation. There is a high probability that the Impact will occur.

None of the proposed alternatives is preferred as the palaeontological resources will be impacted equally by both the alternatives. The implementation of the recommended mitigation measure will reduce the current HIGH rated impact and will have a post-mitigation rating of LOW.

3 FINDINGS

Banzai Environmental was appointed by PGS Heritage (Pty) Ltd to conduct the PIA to assess the Palaeontology for the Springfield Mining Right Application located between Vereeniging and Meyerton in Gauteng. The National Heritage Resources Act (No 25 of 1999, section 38) (NHRA), specifies that a PIA is key to detect the presence of fossil material within the planned mining rights application area. This PIA of the proposed project is thus necessary to evaluate the effect of the construction on local palaeontological resources.

The geology of the proposed Springfield Project is primarily underlain by the Vryheid Formation (Ecca Group, Undifferentiated Karoo), Precambrian dolomites and associated marine sedimentary rocks that are allocated to the Malmani Subgroup (Chuniespoort Group, Transvaal Supergroup), as well as Quaternary superficial deposits. According to the PalaeoMap on the South African Heritage Resources Information System (SAHRIS) database, the Palaeontological Sensitivity of the Vryheid Formation (Ecca Group, Undifferentiated Karoo) is Very High, while that of the Malmani Subgroup is High and Quaternary deposits is High (Almond and Pether 2008, SAHRIS website). Groenewald and Groenewald 2014 allocated a High Sensitivity to the Malmani Subgroup. They noted that additionally to the stromatolites, potentially fossiliferous Late Caenozoic Cave breccias within the “Transvaal dolomite” outcrop area could be present. These breccias are not individually mapped on geological maps.

The Vryheid Formation comprise of a rich assemblage of Glossopteris flora. The Malmani Subgroup carbonates of the Transvaal Basin comprise of an assortment of stromatolites (microbial laminates), ranging from supratidal mats to intertidal columns and large subtidal domes. Late Cenozoic deposits may contain molluscs, mammalian bones and teeth and horn. Tortoise remains have also been uncovered, as well as trace fossils - which include termite and insect’s burrows and mammalian trackways. Plant remains include leaves, fossil wood, pollen of vascular plants, as well as diatoms.

A one-day site specific field survey of the proposed Springfield Colliery was conducted on foot and by motor vehicle on 5 September 2020. Several loose stromatolites were identified in a pile in the eastern side of the mining rights application area outside of the proposed project footprint areas. There is thus a chance that other stromatolite fossils could be present just below the surface of the mining rights application area. Although this locality does not currently fall in the proposed footprint areas, this fossiliferous site has been identified as Highly Sensitive and No-go areas and it is recommended that a 50 m buffer will be placed around the stromatolite areas. If construction is necessity in this sensitive area, it is recommended that mitigation will be conducted by a professional palaeontologist.

Furthermore, it is highly possible that other fossils could also be present just below the surface of the development footprint. By implementing mitigation measures the significance of the impact will be reduced to LOW. Mitigation should take place after initial vegetation is cleared away but *before* the ground is levelled for construction. Preceding excavation of any fossil material, the specialist would need to apply for a collection permit from SAHRA. Fossil material must be curated in an accredited collection (museum or university collection), while all fieldwork and reports should meet the minimum standards for palaeontological impact studies suggested by SAHRA.

If fossil remains are discovered during any phase of the operation, either on the surface or exposed by fresh excavations the **Chance Find Protocol** must be implemented by the ECO in charge of these developments. These discoveries ought to be protected (if probable, *in situ*) and the ECO must report to SAHRA (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za) so that correct mitigation can be carry out by a paleontologist.

It is consequently recommended that no further palaeontological heritage studies, ground truthing and/or specialist mitigation are required pending the discovery of newly discovered fossils. However, it is recommended that the mitigation measures are included in the EMPr and fully implemented.

Recommendations:

- The EAP and ECO for this project must be informed that Vryheid Formation (Ecca Group, Undifferentiated Karoo), Precambrian dolomites and associated marine sedimentary rocks that are allocated to the Malmani Subgroup (Chuniespoort Group, Transvaal Supergroup), as well as Quaternary superficial deposits has a high to very high Palaeontological Sensitivity.
- Fossils may also be present in the mining rights application area. If fossil remains are discovered during any phase of construction, either on the surface or exposed by new excavations the **Chance Find Protocol** must be implemented by the ECO in charge of these developments. These discoveries ought to be secured (if possible, *in situ*) and the ECO ought to alert SAHRA so that appropriate mitigation (documented and collection) can be undertaken by a palaeontologist.

These recommendations must form part of the Heritage Management Plan for Springfield Colliery.

4 CHANCE FINDS PROTOCOL

The following procedure will only be followed if fossils are uncovered during excavation.

4.1 Legislation

Cultural Heritage in South Africa (includes all heritage resources) is protected by the **National Heritage Resources Act (Act 25 of 1999) (NHRA).** According to Section 3 of the Act, all Heritage resources include **"all objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens**".

Palaeontological heritage is unique and non-renewable and is protected by the NHRA and are the property of the State. It is thus the responsibility of the State to manage and conserve fossils on behalf of the citizens of South Africa. Palaeontological resources may not be excavated, broken, moved, or destroyed by any development without prior assessment and without a permit from the relevant heritage resources authority as per section 35 of the NHRA.

4.2 Background

A fossil is the naturally preserved remains (or traces) of plants or animals embedded in rock. These plants and animals lived in the geologic past millions of years ago. Fossils are extremely rare and irreplaceable. By studying fossils, it is possible to determine the environmental conditions that existed in a specific geographical area millions of years ago.

4.3 Introduction

This informational document is intended for workmen and foremen on construction sites. It describes the actions to be taken when mining or construction activities accidentally uncovers fossil material.

It is the responsibility of the Environmental Control Officer (ECO) of the project to train the workmen and foremen in the procedure to follow when a fossil is accidentally uncovered. In the absence of the ECO, a member of the staff must be appointed to be responsible for the proper implementation of the chance find protocol as not to compromise the conservation of fossil material.

4.4 Chance Find Procedure

- If a chance find is made the person responsible for the find must immediately **stop working** and all work must cease in the immediate vicinity of the find.
- The person who made the find must immediately **report** the find to his/her direct supervisor which in turn must report the find to his/her manager and the ECO or site manager. The ECO must report the find to the relevant Heritage Agency (South African Heritage Research Agency, SAHRA). (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za). The information to the Heritage Agency must include photographs of the find, from various angles, as well as the GPS co-ordinates.
- A preliminary report must be submitted to the Heritage Agency within **24 hours** of the find and must include the following: 1) date of the find; 2) a description of the discovery and a 3) description of the fossil and its context (depth and position of the fossil), GPS co-ordinates.
- Photographs (the more the better) of the discovery must be of high quality, in focus, accompanied by a scale. It is also important to have photographs of the vertical section (side) where the fossil was found.

Upon receipt of the preliminary report, the Heritage Agency will inform the ECO (site manager) whether a rescue excavation or rescue collection by a palaeontologist is necessary.

- The site must be secured to protect it from any further damage. **No attempt** should be made to remove material from their environment. The exposed finds must be stabilized and covered by a plastic sheet or sand bags. The Heritage agency will also be able to advise on the most suitable method of protection of the find.
- In the event that the fossil cannot be stabilized the fossil may be collected with extreme care by the ECO (site manager). Fossils finds must be stored in tissue paper and in an appropriate box while due care must be taken to remove all fossil material from the rescue site.
- Once Heritage Agency has issued the written authorization, the developer may continue with the development.

5 REFERENCES

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BAMFORD M, 2018a. Palaeontological Impact Assessment for the proposed glass bottle manufacturing plant, farm Leeuwkuil 596 IQ, Vereeniging, Gauteng Province.

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Appendix A – Elize Butler CV

CURRICULUM VITAE: ELIZE BUTLER

PROFESSION: Palaeontologist

YEARS' EXPERIENCE: 26 years in Palaeontology

EDUCATION:

B.Sc Botany and Zoology, 1988
University of the Orange Free State

B.Sc (Hons) Zoology, 1991
University of the Orange Free State

Management Course, 1991
University of the Orange Free State

M. Sc. *Cum laude* (Zoology), 2009
University of the Free State

Dissertation title: The postcranial skeleton of the Early Triassic non-mammalian Cynodont *Galesaurus planiceps*: implications for biology and lifestyle

MEMBERSHIP

Palaeontological Society of South Africa (PSSA) 2006-currently

EMPLOYMENT HISTORY

Part-time Laboratory assistant Department of Zoology & Entomology University of the Free State Zoology 1989-1992

Part-time laboratory assistant Department of Virology
University of the Free State Zoology 1992

Research Assistant National Museum, Bloemfontein 1993 – 1997

Principal Research Assistant National Museum, Bloemfontein
and Collection Manager 1998–currently

TECHNICAL REPORTS

Butler, E. 2014. Palaeontological Impact Assessment of the proposed development of private dwellings on portion 5 of farm 304 Matjesfontein Keurboomstrand, Knysna District, Western Cape Province. Bloemfontein.

Butler, E. 2014. Palaeontological Impact Assessment for the proposed upgrade of existing water supply infrastructure at Noupoort, Northern Cape Province. 2014. Bloemfontein.

Butler, E. 2015. Palaeontological impact assessment of the proposed consolidation, re-division and development of 250 serviced erven in Nieu-Bethesda, Camdeboo local municipality, Eastern Cape. Bloemfontein.

Butler, E. 2015. Palaeontological impact assessment of the proposed mixed land developments at Rooikraal 454, Vrede, Free State. Bloemfontein.

Butler, E. 2015. Palaeontological exemption report of the proposed truck stop development at Palmiet 585, Vrede, Free State. Bloemfontein.

Butler, E. 2015. Palaeontological impact assessment of the proposed Orange Grove 3500 residential development, Buffalo City Metropolitan Municipality East London, Eastern Cape. Bloemfontein.

Butler, E. 2015. Palaeontological Impact Assessment of the proposed Gonubie residential development, Buffalo City Metropolitan Municipality East London, Eastern Cape Province. Bloemfontein.

Butler, E. 2015. Palaeontological Impact Assessment of the proposed Ficksburg raw water pipeline. Bloemfontein.

Butler, E. 2015. Palaeontological Heritage Impact Assessment report on the establishment of the 65 mw Majuba Solar Photovoltaic facility and associated infrastructure on portion 1, 2 and 6 of the farm Witkoppies 81 HS, Mpumalanga Province. Bloemfontein.

Butler, E. 2015. Palaeontological Impact Assessment of the proposed township establishment on the remainder of portion 6 and 7 of the farm Sunnyside 2620, Bloemfontein, Mangaung metropolitan municipality, Free State, Bloemfontein.

Butler, E. 2015. Palaeontological Impact Assessment of the proposed Woodhouse 1 photovoltaic solar energy facilities and associated infrastructure on the farm Woodhouse729, near Vryburg, North West Province. Bloemfontein.

Butler, E. 2015. Palaeontological Impact Assessment of the proposed Woodhouse 2 photovoltaic solar energy facilities and associated infrastructure on the farm Woodhouse 729, near Vryburg, North West Province. Bloemfontein.

Butler, E. 2015. Palaeontological Impact Assessment of the proposed Orkney solar energy farm and associated infrastructure on the remaining extent of Portions 7 and 21 of the farm Wolvehuis 114, near Orkney, North West Province. Bloemfontein.

Butler, E. 2015. Palaeontological Impact Assessment of the proposed Spectra foods broiler houses and abattoir on the farm Maiden Manor 170 and Ashby Manor 171, Lukhanji Municipality, Queenstown, Eastern Cape Province. Bloemfontein.

Butler, E. 2016. Palaeontological Impact Assessment of the proposed construction of the 150 MW Noupoort concentrated solar power facility and associated infrastructure on portion 1 and 4 of the farm Carolus Poort 167 and the remainder of Farm 207, near Noupoort, Northern Cape. Prepared for Savannah Environmental. Bloemfontein.

Butler, E. 2016. Palaeontological Impact Assessment of the proposed Woodhouse 1 Photovoltaic Solar Energy facility and associated infrastructure on the farm Woodhouse 729, near Vryburg, North West Province. Bloemfontein.

Butler, E. 2016. Palaeontological Impact Assessment of the proposed Woodhouse 2 Photovoltaic Solar Energy facility and associated infrastructure on the farm Woodhouse 729, near Vryburg, North West Province. Bloemfontein.

Butler, E. 2016. Proposed 132kV overhead power line and switchyard station for the authorised Solis Power 1 CSP project near Upington, Northern Cape. Bloemfontein.

Butler, E. 2016. Palaeontological Impact Assessment of of the proposed Senqu Pedestrian Bridges in Ward 5 of Senqu Local Municipality, Eastern Cape Province. Bloemfontein.

Butler, E. 2016. Recommendation from further Palaeontological Studies: Proposed Construction of the Modderfontein Filling Station on Erf 28 Portion 30, Founders Hill, City Of Johannesburg, Gauteng Province. Bloemfontein.

Butler, E. 2016. Recommendation from further Palaeontological Studies: Proposed Construction of the Modikwa Filling Station on a Portion of Portion 2 of Mooihoek 255 Kt, Greater Tubatse Local Municipality, Limpopo Province. Bloemfontein.

Butler, E. 2016. Recommendation from further Palaeontological Studies: Proposed Construction of the Heidedal filling station on Erf 16603, Heidedal Extension 24, Mangaung Local Municipality, Bloemfontein, Free State Province. Bloemfontein.

Butler, E. 2016. Recommended Exemption from further Palaeontological studies: Proposed Construction of the Gunstfontein Switching Station, 132kv Overhead Power Line (Single Or Double Circuit) and ancillary infrastructure for the Gunstfontein Wind Farm Near Sutherland, Northern Cape Province. Savannaha South Africa. Bloemfontein.

Butler, E. 2016. Palaeontological Impact Assessment of the proposed Galla Hills Quarry on the remainder of the farm Roode Krantz 203, in the Lukhanji Municipality, division of Queenstown, Eastern Cape Province. Bloemfontein.

Butler, E. 2016. Chris Hani District Municipality Cluster 9 water backlog project phases 3a and 3b: Palaeontology inspection at Tsomo WTW. Bloemfontein.

Butler, E. 2016. Palaeontological Impact Assessment of the proposed construction of the 150 MW Noupoort concentrated solar power facility and associated infrastructure on portion 1 and 4 of the farm Carolus Poort 167 and the remainder of Farm 207, near Noupoort, Northern Cape. Savannaha South Africa. Bloemfontein.

Butler, E. 2016. Palaeontological Impact Assessment of the proposed upgrading of the main road MR450 (R335) from the Motherwell to Addo within the Nelson Mandela Bay Municipality and Sunday's river valley Local Municipality, Eastern Cape Province. Bloemfontein.

Butler, E. 2016. Palaeontological Impact Assessment construction of the proposed Metals Industrial Cluster and associated infrastructure near Kuruman, Northern Cape Province. Savannaha South Africa. Bloemfontein.

Butler, E. 2016. Palaeontological Impact Assessment for the proposed construction of up to a 132kv power line and associated infrastructure for the proposed Kalkaar Solar Thermal Power Plant near Kimberley, Free State and Northern Cape Provinces. PGS Heritage. Bloemfontein.

Butler, E. 2016. Palaeontological Impact Assessment of the proposed development of two burrow pits (DR02625 and DR02614) in the Enoch Mgijima Municipality, Chris Hani District, Eastern Cape.

Butler, E. 2016. Ezibeleni waste Buy-Back Centre (near Queenstown), Enoch Mgijima Local Municipality, Eastern Cape. Bloemfontein.

Butler, E. 2016. Palaeontological Impact Assessment for the proposed construction of two 5 Mw Solar Photovoltaic Power Plants on Farm Wildebeestkuil 59 and Farm Leeuwbosch 44, Leeudoringstad, North West Province. Bloemfontein.

Butler, E. 2016. Palaeontological Impact Assessment for the proposed development of four Leeuwberg Wind farms and basic assessments for the associated grid connection near Loeriesfontein, Northern Cape Province. Bloemfontein.

Butler, E. 2016. Palaeontological impact assessment for the proposed Aggeneys south prospecting right project, Northern Cape Province. Bloemfontein.

Butler, E. 2016. Palaeontological impact assessment of the proposed Motuoane Ladysmith Exploration right application, Kwazulu Natal. Bloemfontein.

Butler, E. 2016. Palaeontological impact assessment for the proposed construction of two 5 MW solar photovoltaic power plants on farm Wildebeestkuil 59 and farm Leeuwbosch 44, Leeudoringstad, North West Province. Bloemfontein.

Butler, E. 2016: Palaeontological desktop assessment of the establishment of the proposed residential and mixed use development on the remainder of portion 7 and portion 898 of the farm Knopjeslaagte 385 Ir, located near Centurion within the Tshwane Metropolitan Municipality of Gauteng Province. Bloemfontein.

Butler, E. 2017. Palaeontological impact assessment for the proposed development of a new cemetery, near Kathu, Gamagara local municipality and John Taolo Gaetsewe district municipality, Northern Cape. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment Of The Proposed Development Of The New Open Cast Mining Operations On The Remaining Portions Of 6, 7, 8 And 10 Of The Farm Kwaggafontein 8 In The Carolina Magisterial District, Mpumalanga Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment for the Proposed Development of a Wastewater Treatment Works at Lanseria, Gauteng Province. Bloemfontein.

Butler, E. 2017. Palaeontological Scoping Report for the Proposed Construction of a Warehouse and Associated Infrastructure at Perseverance in Port Elizabeth, Eastern Cape Province.

Butler, E. 2017. Palaeontological Desktop Assessment for the Proposed Establishment of a Diesel Farm and a Haul Road for the Tshipi Borwa mine Near Hotazel, In the John Taolo Gaetsewe District Municipality in the Northern Cape Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment for the Proposed Changes to Operations at the UMK Mine near Hotazel, In the John Taolo Gaetsewe District Municipality in the Northern Cape Province. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment for the Development of the Proposed Ventersburg Project-An Underground Mining Operation near Ventersburg and Henneman, Free State Province. Bloemfontein.

Butler, E. 2017. Palaeontological desktop assessment of the proposed development of a 3000 MW combined cycle gas turbine (CCGT) in Richards Bay, Kwazulu-Natal. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment for the Development of the Proposed Revalidation of the lapsed General Plans for Elliotdale, Mbhashe Local Municipality. Bloemfontein.

Butler, E. 2017. Palaeontological assessment of the proposed development of a 3000 MW Combined Cycle Gas Turbine (CCGT) in Richards Bay, Kwazulu-Natal. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed development of the new open cast mining operations on the remaining portions of 6, 7, 8 and 10 of the farm Kwaggafontein 8 10 in the Albert Luthuli Local Municipality, Gert Sibande District Municipality, Mpumalanga Province. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed mining of the farm Zandvoort 10 in the Albert Luthuli Local Municipality, Gert Sibande District Municipality, Mpumalanga Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment for the proposed Lanseria outfall sewer pipeline in Johannesburg, Gauteng Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed development of open pit mining at Pit 36W (New Pit) and 62E (Dishaba) Amandelbult Mine Complex, Thabazimbi, Limpopo Province. Bloemfontein.

Butler, E. 2017. Palaeontological impact assessment of the proposed development of the sport precinct and associated infrastructure at Merrifield Preparatory school and college, Amathole Municipality, East London. PGS Heritage. Bloemfontein.

Butler, E. 2017. Palaeontological impact assessment of the proposed construction of the Lehae training and fire station, Lenasia, Gauteng Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed development of the new open cast mining operations of the Impunzi mine in the Mpumalanga Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the construction of the proposed Viljoenskroon Munic 132 KV line, Vierfontein substation and related projects. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed rehabilitation of 5 ownerless asbestos mines. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed development of the Lephalale coal and power project, Lephalale, Limpopo Province, Republic of South Africa. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed construction of a 132KV powerline from the Tweespruit distribution substation (in the Mantsopa local municipality) to the Driedorp rural substation (within the Naledi local municipality), Free State province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed development of the new coal-fired power plant and associated infrastructure near Makhado, Limpopo Province. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed construction of a Photovoltaic Solar Power station near Collett substation, Middelburg, Eastern Cape. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment for the proposed township establishment of 2000 residential sites with supporting amenities on a portion of farm 826 in Botshabelo West, Mangaung Metro, Free State Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment for the proposed prospecting right project without bulk sampling, in the Koa Valley, Northern Cape Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment for the proposed Aroams prospecting right project, without bulk sampling, near Aggeneys, Northern Cape Province. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed Belvior aggregate quarry II on portion 7 of the farm Maidenhead 169, Enoch Mgijima Municipality, division of Queenstown, Eastern Cape. Bloemfontein.

Butler, E. 2017. PIA site visit and report of the proposed Galla Hills Quarry on the remainder of the farm Roode Krantz 203, in the Lukhanji Municipality, division of Queenstown, Eastern Cape Province. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed construction of Tina Falls Hydropower and associated power lines near Cumbu, Mthlontlo Local Municipality, Eastern Cape. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed construction of the Mangaung Gariep Water Augmentation Project. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed Belvoir aggregate quarry II on portion 7 of the farm Maidenhead 169, Enoch Mgijima Municipality, division of Queenstown, Eastern Cape. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed construction of the Melkspruit-Rouxville 132KV Power line. Bloemfontein.

Butler, E. 2017 Palaeontological Desktop Assessment of the proposed development of a railway siding on a portion of portion 41 of the farm Rustfontein 109 is, Govan Mbeki local municipality, Gert Sibande district municipality, Mpumalanga Province. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed consolidation of the proposed Ilima Anthracite Mine in the Albert Luthuli local municipality, Gert Sibande District Municipality, Mpumalanga Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed extension of the Kareerand Tailings Storage Facility, associated borrow pits as well as a storm water drainage channel in the Vaal River near Stilfontein, North West Province. Bloemfontein.

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